

Appl. No. 10/047,613

Amdt. Dated December 24, 2003

Reply to Office Action of September 24, 2003

SPECIFICATION AMENDMENTS

Please replace the previously presented paragraph starting on page 1, line 7 with the following amended paragraph:

The invention relates to a laser diode with a vertical resonator having a shaper for shaping the beam profile of the laser diode with at least one bleaching ~~decoloring~~ absorber in a vertical resonator and to an optical system, in particular a CD player or a data transmission system, with such a laser diode

Please replace the three previously presented paragraphs on page 2, starting on line 5 with the following three amended paragraphs:

This object is achieved according to the invention by a laser diode with a vertical resonator having a shaper for shaping the beam profile of the laser diode with at least one bleaching ~~decoloring~~ absorber in a vertical resonator.

An important part of the invention is the introduction of a means for beam profiling, the means having at least one absorber means with a bleaching by decoloring (saturable) absorber.

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The at least one bleaching ~~decelerating~~ absorber means favors emission of the dominant transverse mode with highest optical intensity (for example transverse fundamental Gaussian mode with its intensity maximum on the axis), since the bleaching ~~decelerating~~ of the absorber is at its greatest at the locations of greatest intensity.

Please replace the last two paragraphs beginning on page 2, line 19 with the following amended paragraph:

~~Decelerating~~ Bleaching absorbers or ~~decelerating~~ bleaching quantum films are known per se as optical absorbers with nonlinear absorption behavior. The transmission of the ~~decelerating~~ bleaching absorbers depends on the irradiated radiation intensity. With increasing power densities, the absorption decreases; at very high power densities, the absorber is substantially transparent. The use of absorber means for semiconductor lasers is known in principle (for example from US-A-5,574,738), these absorber means only being used to absorb certain wavelengths of the radiation, to achieve self-modulation of the laser diode in the GHz range.

The invention is concerned with the fact that light in the vertical resonator has in principle an inhomogeneous intensity distribution over the beam cross section, the

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~~decelerating~~ bleaching absorber means ensuring that the light is attenuated only little at the locations of high intensity in the absorber means.

Please replace the last two paragraphs on page 3 beginning at line 16 with the following two amended paragraphs:

This form of operation is preferred in optical scanning systems, for example in a CD player. In addition, the local charge carrier generation by absorption in the ~~decelerating~~ bleaching absorber means has the effect of promoting the current injection near the axis of the active zone, which in turn is advantageous for the fundamental mode emission.

Use of the laser diode according to the invention also allows the dynamic performance of the switching-on and switching-off operation of optical data transmission devices to be improved. In these operations, the build-up of oscillations of other, in particular higher, transverse modes occurs. Use of a ~~decelerating~~ bleaching absorber means in the laser diode stabilizes the emission on the dominant transverse mode (for example transverse fundamental mode) and consequently prevents the undesired occurrence of pattern effects in the transmission of digital signal sequences. As a result, higher data transmission rates and a more stable mode

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behavior can be achieved over a wide temperature range.

Furthermore, fundamental mode operation is consequently possible with larger component dimensions, so that the required production tolerances are reduced.

Please replace the paragraph beginning on page 4, line 23 with the following amended paragraph:

In a further advantageous configuration of the laser diode according to the invention, at least one ~~decoloring~~ bleaching absorber means is formed as a layer in the vertical resonator, the thickness of the layer being small, approaching a quarter of the material wavelength. It is also advantageous if at least one absorber means is formed as a layer with the thickness of the layer being greater than a quarter of the material wavelength. Selection of the layer thickness of one or more layers allows the absorption behavior to be varied.

Please replace the first previously presented paragraph after the Description of the Preferred Embodiment heading with the following amended paragraph:

Referring now to the figures of the drawings in detail and first, particularly to FIG. 1 thereof, there is shown a

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vertical laser diode with an integrated ~~decoloring~~ absorber layer 50 with an bleaching absorber means 5. The vertical laser diode having, as the lowermost layer, an n-doped GaAs substrate 1, which is provided with a GeNiAu contact 10.

Please replace the paragraph beginning on page 6, line 6 with the following amended paragraph:

The structure outlined in figure 1 of a vertical laser diode with an integrated ~~decoloring~~ bleaching absorber layer 50 with an absorber means 5 has, as the lowermost layer, an n-doped GaAs substrate 1, which is provided with a GeNiAu contact 10.

Please replace the two paragraphs beginning on page 6, line 28 and page 7, line 1 with the following two amended paragraphs:

Arranged in the absorber layer 50 as the ~~decoloring~~ bleaching absorber means 5 is an 8 nm thick In<sub>0.2</sub>Ga<sub>0.8</sub>As quantum film. This is surrounded on both sides by in each case 10 nm thick GaAs barriers, these layers all having a doping of  $p = 5 \times 10^{17} \text{ cm}^3$  (see figure 2).

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Serving as the ~~decoloring~~ bleaching absorber means 5 as such is the  $\text{In}_{0.2}\text{Ga}_{0.8}\text{As}$  quantum film. The transparency of the absorber means 5 increases with increasing irradiation intensity, so that at high intensities the absorber means is substantially transparent. In the case of such quantum films, the intensity critical for the bleaching by decoloring lies around  $1 \text{ kW/cm}^2$ .

Please replace the previously presented paragraph beginning on page 8, line 26 and the next paragraph beginning on page 8, line 31 with the following two amended paragraphs:

The absorber means 5 has an 8 nm thick  $\text{In}_{0.2}\text{Ga}_{0.8}\text{As}$  quantum film 5 with 10 nm thick GaAs barriers on both sides, which altogether have a doping of  $p = 5 \times 10^{17} \text{ cm}^{-3}$ . In an alternative configuration, the ~~decoloring~~ bleaching absorber means 5 may be undoped.

The relative position of the ~~decoloring~~ bleaching absorber means 5 in the standing wave field 100 determines the critical average intensity which is necessary for reaching the transparent state.

Please replace the paragraph beginning on page 10, line 2 with the following amended paragraph:

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Alternative forms of construction than the configuration outlined, with a plurality of thin ~~decoloring~~ bleaching absorber layers or solid saturable structures, are of course possible. Similarly, the structure is not restricted to the InAlGaAs semiconductor system, but can also be realized for example in the material systems of InGaAsP (for example on an InP substrate) or InAlGaAsN (for example on a sapphire, SiC or GaAs substrate). The vertical laser structure can also be realized in II-VI semiconductor systems, such as ZnMgBeSSe for example.

Please replace the paragraph beginning on page 10, line 25 with the following amended paragraph:

In the embodiment described here, only one absorber means is used in the vertical resonator. It is also possible in principle, in alternative embodiments, to use the principle of transverse mode selection for integrating a plurality of ~~decoloring~~ bleaching or saturable absorber means. This is appropriate in the case in which, for example, a plurality of active layers are provided in a stack of layers, as occurs in the case of a multistage vertically emitting laser diode (cascaded laser diode). In cascaded laser diodes, the active regions are electrically coupled with one another by tunnel

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diodes operated in the reverse direction, thereby achieving a higher optical gain in the vertical resonator.

Please replace the paragraph beginning on page 11, line 7 with the following amended paragraph:

In any event (i.e. in the case of one or more absorber means 5), the optical bleaching by decoloring of the absorber can be additionally assisted by local current constriction.